Fairchild

MODEL 131

PULSE GENERATOR

SERIAL NOS. PREFIXED A

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND 20, CALIFORNIA

MODEL 131

PULSE GENERATOR

SERIAL NOS. PREFIXED A

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E-H MODEL 131 PULSE GENERATOR

Make the following changes in the parts list and schematics for instruments:

SERIAL NUMBERS A-0381 AND ABOVE

1. Add diode CR107 in parallel with C121. The cathode is at the junction of R120 and C121. CR107 is a type 1N270, E-H Part Number 376-031.

ERRATA

E-H MODEL 131 PULSE GENERATOR

Make the following corrections and additions in the parts list and on the schematics for all instruments with serial numbers prefixed "A":

1. Add C130 and C134 between the +300 LIMITED and ground. Same as C108.

2. Add C102 and C104 between Vo and the cathode of V101A. C102 is the same as C108. C104 is the same as C3.

3. Change R266 from 12K, 5%, 1/2w, fixed, composition resistor to a 15K, ± 5%, 1/2w, fixed, composition resistor.

4. Change R20 from 160K, 5%, 1/2w, fixed, composition to a 150K, ± 5%, 1/2w, fixed, composition resistor.

5. Reverse the order of C222-C225 on the width switch.

SPECIFICATIONS

The E-H Model 131 Pulse Generator is designed to provide fast rise time, high current pulses over a broad range of pulse widths and repetition rates. It is suitable for a variety of applications including design problems involving magnetic materials, solid state research, high speed diode and transistor switching characteristics, and high current logic and memory circuits. It includes provisions for external driving or gating, provides a trigger for sync purposes, and an output attenuator.

REPETITION RATE:

10 cps to 100 KC internally controlled, zero to 100 KC externally driven.

RISE AND FALL TIMES:

Typically 10 nanoseconds (10 per cent to 90 per cent).

PULSE OUTPUT:

50 volts.

OUTPUT IMPEDANCE:

50 ohms.

PULSE WIDTH:

100 nanoseconds to 500 microseconds, continuously variable.

PULSE DELAY:

Minus 1 to plus 1000 microseconds with respect to the trigger, continuously variable.

POLARITY:

Positive or negative pulses, selected on the front panel.

DUTY FACTOR:

10 per cent at full amplitude; 25 per cent at reduced amplitude. An automatic limiter prevents overload.

OUTPUT ATTENUATOR:

Up to 500:1, 8 position coarse selector and continuous vernier control.

JITTER:

Less than 0.2 per cent plus 4 nanoseconds.

TRIGGER:

Positive 10 volt pulse.

EXTERNAL DRIVE:

2 volts RMS or positive pulse required.

ELECTRONIC GATE:

Positive 2 volts required to block the pulse train.

ACCESSORIES

Use the Model ZT Series Pulse Transformers to invert the output pulse or to match other impedances. Standard impedances are any permutation of 50, 93, 125, 185 or 200 ohms, normal or inverting. Coaxial body with BNC connectors. Price $35.

Use Model RT Rise Time Integrators to obtain precise rise times in applications where responses to slower rise times are important. Standard rise times of 5, 10, 20, 50, and 100 nanoseconds; other values on special order. Price $35.

Use Model 921 Variable Delay Generator between an external driving source and a Model 131 to obtain precision pulse positioning; or between two or more Model 131's. Continuously variable delays from 50 nanoseconds to 100 microseconds. Price $425.

The coarse DELAY selector and the FINE vernier provide continuous control over the relative position of the trigger output and the pulse output. The pulse output can be advanced one microsecond or delayed up to 1000 microseconds with respect to the trigger output.

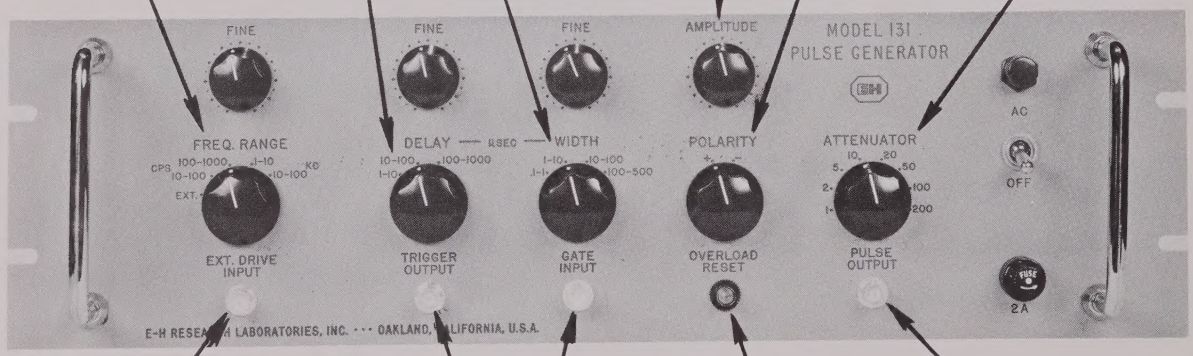
The amplitude of the output pulse is continuously variable over an approximate 3:1 range by the AMPLITUDE control.

The POLARITY switch selects either positive or negative output pulses.

The internal repetition rate is controlled by a coarse FREQ. RANGE selector which is calibrated in decade steps. The FINE control provides continuous coverage within the selected decade range.

The coarse WIDTH selector switch and FINE control vary the width of the output pulses from .1 to 500 microseconds.

The eight step ATTENUATOR provides attenuation from 1:1 to 200:1.



To drive the instrument externally, the FREQ. RANGE selector must be set to EXT. and two volt positive pulse applied to the EXT. DRIVE INPUT connector.

The trigger output is a positive 10 volt pulse.

A positive two volt signal applied to the GATE INPUT will interrupt the pulse train as long as the signal remains.

The pulse train is taken from the PULSE OUTPUT connector. The output is designed to operate into a 50 ohm, resistive load.

The OVERLOAD RESET is a visual indication that the duty cycle limitation has been exceeded. The duty cycle should be corrected and the reset button pushed to restore normal operation.

OPERATING INFORMATION

1. 230 VOLT OPERATION

The internal power supply of the Model 131 is normally wired for 115 volt operation. Simple rewiring of the transformer primary permits operation at 230 volts. Refer to the schematic diagram at the back of this manual for the proper primary connection to provide operation at 230 volts.

2. CONTROLS

All operating controls and connectors are mounted on the front panel. The figure on the opposite page shows the location and describes the operation of each control.

3. OUTPUT IMPEDANCE

The Model 131 is a current source when the output pulse is negative and a voltage source when the output pulse is positive. Although the impedance at the output connector is not 50 ohms, the instrument is designed to operate into a 50 ohm resistive load. Operation into any other impedance will cause some pulse distortion. Loads with appreciable capacitive or inductive components will have a marked effect on the leading and falling edges of the pulse.

Use the Model ZT Pulse Transformer to match the Model 131 output to other impedances.

CAUTION

Operation of the instrument unterminated and with the ATTENUATOR set to 1 can affect the life of the output tubes.

4. DUTY CYCLE

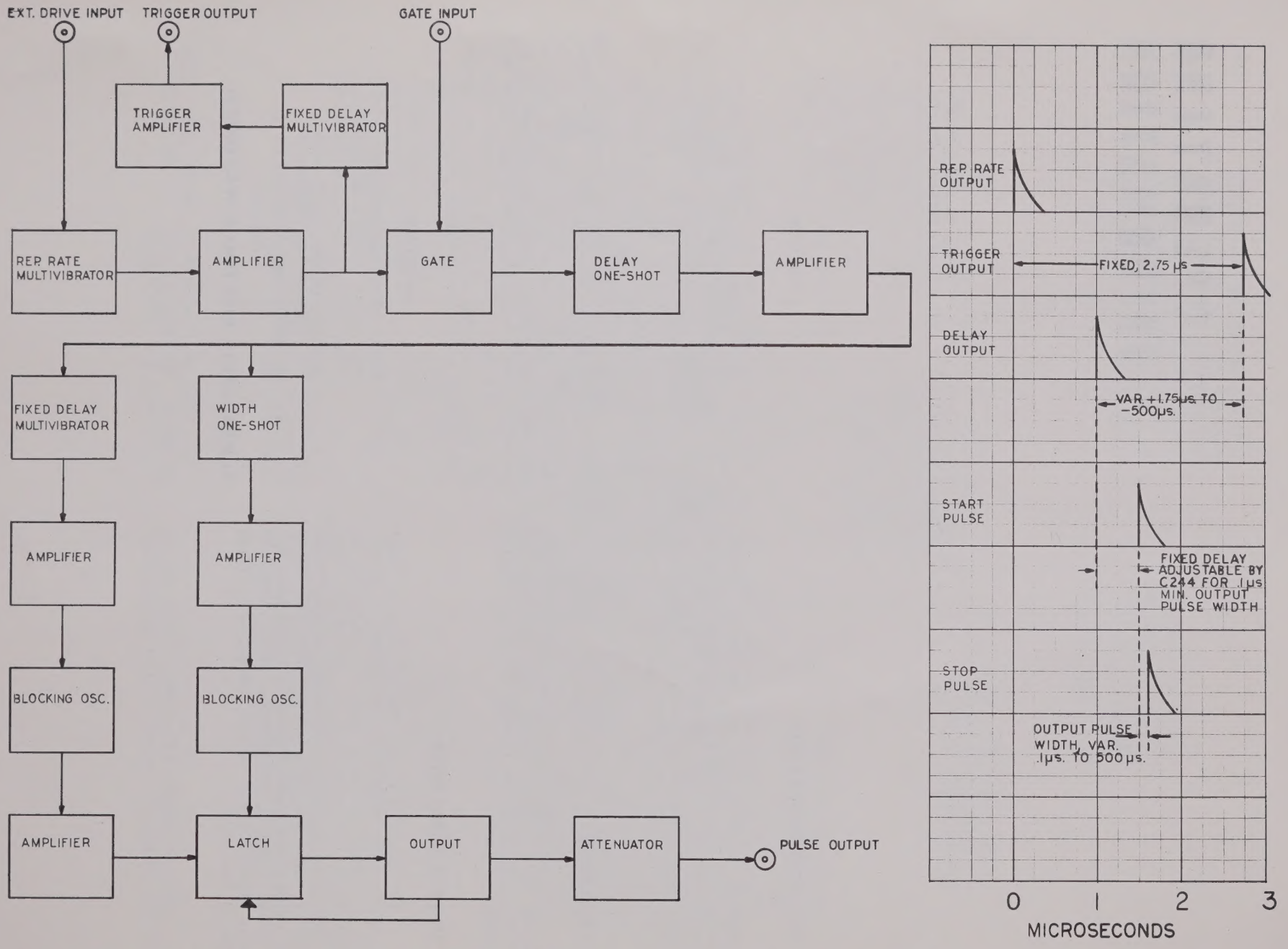
The duty cycle limitation is to insure long life by conservative operation of the output tubes. The overload relay is typically adjusted so that duty cycles slightly greater than those specified are obtainable. Do not defeat the purpose of the overload relay by altering it to obtain higher duty cycles. To do so will cause excessive drain on the power supply and also will exceed the dissipation ratings of the output tubes.

CAUTION

Before pressing the overload reset button, always reduce the duty cycle to within specifications. Never hold the reset button depressed for more than a second or two.

5. MEASURING RISE TIME & WAVEFORM

This is discussed in detail under paragraph G, "OUTPUT PULSE," in the section on Maintenance and Calibration.



BLOCK DIA. & TIME RELATIONS DIA.

THEORY OF OPERATION

GENERAL DESCRIPTION

Refer to the block diagram and the time relations diagram on the opposite page.

The basic timing cycle is initiated by a symmetric multivibrator, which may be free running or externally driven. The output from the repetition rate multivibrator is differentiated, amplified, and applied to a gate circuit which passes the signal to the delay one-shot multivibrator unless a voltage is applied to the gate input, which then blocks the pulse train. The output of the amplifier is also coupled through a fixed delay to the trigger output amplifier.

The purpose of the fixed delay is so that the output pulse can be advanced with respect to the trigger output, by approximately one microsecond.

The delay one-shot multivibrator determines the position of the output pulse with respect to the trigger. The signal from the delay one-shot is amplified and goes to the width one-shot multivibrator, which determines the width of the output pulse.

The signal from the delay amplifier is also applied through a fixed delay and amplifier to a blocking oscillator to initiate the start of the output pulse. The fixed delay allows the minimum pulse width to be less than the minimum timing period capability of the width one-shot.

The output from the width one-shot amplifier is also applied to a blocking oscillator to initiate the stop of the output pulse. The blocking oscillators provide very high amplitude, fast rising signals to drive the latch. The latch is a quasi-stable circuit which is turned on by the start signal and remains in that state, providing a constant amplitude output level, until turned off by the stop signal.

REPETITION RATE MULTIVIBRATOR

Transistors Q201 through Q204 comprise a non-saturating multivibrator. Switch S201, the coarse frequency selector switch, is shown in the external drive position. In any of the other positions, the multivibrator operates as a standard astable multivibrator circuit with timing capacitors C203 through C211 in series with resistors R203 and R212. The fine frequency control pots are R204 and R213. Transistors Q201 and Q204 are emitter followers to increase the input impedance of the multivibrator. R205, CR201, R214, and CR204 prevent the transistors from saturating. CR202 and CR203 drive the bases of Q202 and Q203 positive to insure that they are turned off, thus increasing the switching time of the multivibrator. When the transistor Q202 or Q203 is conducting, its emitter will be within a few tenths of a volt of ground. Thus, there will be 15 milliamps going through the transistor that is on, through either collector resistor R207 or R210. Voltage drop across R207 or R210 will be less than 15 volts, thus insuring that the transistors Q202 or Q203 will not be saturated.

When the frequency range switch, S201, is in the external drive position, the multivibrator is changed into a one-shot circuit with Q201 and Q202 normally conducting the on current which is provided from the -15 volt bus through R201. Turn-off bias for transistors Q204 and Q203 is provided through the resistor divider R215 and R216 from the +15 volt bus. A positive input with respect to ground at the external drive input turns off transistors Q201 and Q202. The collector of Q202 then goes negative and drives the base of Q204 negative through capacitor C207, which turns on transistor Q203. The collector of transistor Q203 then goes positive to produce the output of the multivibrator.

TRIGGER CIRCUITRY

The output from the multivibrator is coupled from the collector of Q203 through C212 to the base of Q205. Q205 is normally biased off by resistors R217 and R218 so that only the positive going portion of the waveform from the multivibrator causes the transistor Q205 to conduct. The collector of transistor Q205 will normally be at +15 volts, and it is driven into saturation so that there will be a 15 volt negative swing at the collector of Q205. The negative leading edge of this pulse is coupled through C235 to trigger the trigger output delay one-shot multivibrator. The trigger output delay one-shot is made up of transistors Q219 and Q220 and followed by the amplifier transistor Q218. This is a non-saturating one-shot, the period of which is determined by the capacitor C234 and the resistor R266. In its normal state, transistor Q220 is prevented from going much below ground by CR211 and resistor R267. The emitter of transistor Q220 will then be very close to ground; and, thus, there will be approximately 10 milliamps flowing in the emitter circuit. With 10 milliamps flowing through R265 there will be, therefore, about 5 volts across transistor Q220 and it will not be saturated.

A negative pulse coupled through C235 turns off Q220 and the common emitter of Q219, and Q220 begins to go toward -15 volts. The emitter of Q219 drops to the base voltage determined by R261 and R262, and it begins to conduct. The collector of Q219 then goes negative, driving the base of Q220 negative through capacitor C234. The base of Q220 then begins to charge back toward +15 volts, the time constant determined by C234 and R266. When the base of Q220 charges back to the emitter voltage, Q220 begins to conduct and drags the emitter of Q219 positive and, thus, turns off Q219. Then the collector of Q219 goes positive, driving the base of Q220 more positive. causing it to conduct hard; and, thus, the collector of Q220 goes negative. This negative going waveform is coupled through the capacitor C233 into the base of the normally off transistor Q218. Transistor Q218 then starts conducting, and the collector is driven positive producing the trigger output pulse.

GATE CIRCUITRY

The negative going signal from the collector of transistor Q205 is also coupled through C213 into the base of the transistor Q206. Transistors Q206 and Q207 comprise the gating circuit. Transistor Q207 is normally saturated by the current through resistor R221. The collector of transistor Q207 and the emitter of transistor Q206 will be very near ground potential. Transistor Q206 is normally turned off by the dividers R220 and R222. When a negative signal is coupled through C213, the base is made to conduct; and the collector of transistor Q206 then goes positive. When a positive signal is applied to the gate input, transistor Q207 is turned off; and its collector and the emitter of transistor Q206 then fall to the -15 volt level. When a negative signal is then applied to the base transistor of Q206, it will not produce an output and, thus, blocks the pulse from going down the chain. Therefore, when a gate is applied, there will be a trigger output but no start and stop pulses for the output circuitry.

DELAY ONE-SHOT

The positive going output from Q206 is coupled through C214 to trigger the delay one-shot. The delay one-shot is composed of transistors Q208, Q209, and Q210. This one-shot operates in the same manner as the trigger delay one-shot, and the timing period is determined by the capacitors on the switch S202 and the resistors R226 and R227. Q208 is an emitter follower to increase the input impedance of the one-shot. In its normal state, Q209 and Q208 are conducting; and CR206 and R225 act to prevent the bases and, thus, the emitters of transistors Q208 and Q209 from going very far below ground. CR207 couples the positive pulse directly to the base of Q209 to turn it off.

At the end of the timing state, transistor Q209 will again start conducting, causing its collector to go from -15 volts toward ground, thus producing a positive output which is coupled through C218 into the normally off transistor Q211. The negative going signal from the collector of Q211 is coupled through C220 to the base of the transistor Q212. The amplified positive going waveform in the collector of transistor Q212 is coupled through C221 to trigger the width one-shot, and also is coupled through C237 to trigger the start delay one-shot.

The start delay one-shot provides a fixed delay and is comprised of transistors Q221 and Q222. It operates identically to the trigger output delay one-shot, except that the transistors are PNP types and the polarities are, thus, reversed. The timing period of the start delay one-shot is determined by R270 and the capacitors C238 and C244. C244 is a trimmer capacitor and is set to adjust the minimum width of the output pulse.

The output from the start delay one-shot is taken from the collector of transistor Q222 and coupled through capacitor C239 to the base of transistor Q223, an amplifier. The output from transistor Q223 is taken from the collector and is coupled through C241 to the base of transistor Q224. Diode CR213 decouples resistor R280 from the base of transistor Q224 when it is driven negative. Resistors R281 and R282 bias the emitter near +15 volts to obtain a 15 volt swing at the collector of Q224. CR214 isolates Q224 from the following circuitry. The output from the collector of Q224 is coupled through C243 and C101 to the grid of V101A to produce a start pulse.

WIDTH ONE-SHOT

The width one-shot is composed of transistors Q213, Q214, and Q215 and is the same circuitry as the delay one-shot. The output from the width one-shot is taken from the collector of Q214 and is

coupled through capacitor C226 to the base of transistor Q216. The output from Q216 is coupled through capacitor C228 to the base of transistor Q217. The output from Q217 is coupled through CR215 and the capacitor C229 to the grid of V101B to produce a stop pulse.

OUTPUT CIRCUITRY

The start pulse from C243 on the control schematic is coupled through C101 to the grid of V101A. V101A is normally biased off by the resistors R102 and R103. CR101 prevents the trigger pulse to the grid of V101A from being grounded through the transformer T101. T101 starts to conduct and operates as a conventional blocking oscillator. When the blocking oscillator turns off, the backswing of the secondary is coupled through C128 to make the tube turn off fast. The positive backswing of the plate in V101A is coupled through capacitor C109 to the normally off-grid of V102. The off bias on V102 is provided by resistors R111 and R110. V102 and T103 comprise a Class C transformer coupled amplifier. The positive going signal from T103 is coupled through CR104 to the grid of V103A, the latch tube. When V103A starts to conduct, it operates as a cathode follower; and the signal from the cathode drives the grids of the output tubes V104, V105, V106, and V107 positive, causing the output to conduct. A portion of the plate signal from the output tubes V104 through V107 is coupled through R137 and capacitor C124 to the grid of V103B turning it off. Additional signal through R126 and C115 holds it off.

The latch will then remain in this state until a stop pulse is generated. The stop pulse comes from C229 through C103 to the grid of V101B. V101B and T102 form a blocking oscillator identical to V101A and T101. The positive backswing from the plate of V101B is coupled through capacitor C113 and through diode CR106 to the grid of V103B. V103B then conducts in the plate and holds the grid of V103B in the off condition. The plate of V103B also holds the grid of the output tube down through CR110, CR111, and C114, thus turning off the output tubes V104 through V107. The signal from the plates of V104 through V107 is then coupled back to the grid of V103B, causing it to conduct harder. The latch and output then remain in the off position until another start pulse appears.

The latch is turned on by the positive signal through CR104. The grid of V103A rises to the clamp voltage and is held from going more positive than the clamp voltage by CR105. This determines how far positive with respect to the V_O line the grids of the output tubes V104 through V107 go and, thus, determines the output pulse amplitude. The grid of V103B is prevented from going more negative than the bias determined by resistors R155 and R156 and the diode CR113. When the latch is turned off, diode CR108 and resistor R123 prevent the grid of V103B from being driven too far positive. With the latch in the off position, the grids of the output tubes are prevented from going more than -25 volts with respect to V_O through CR116. The plate of V103B is clamped from going more negative than -45 volts by CR104, and the clamp voltage is determined by CR114 in series with CR115.

POLARITY SWITCH

The polarity switch S101 either connects the V_O line to ground in the positive pulse output position or grounds the limited +300 volts in the negative position. R158 through R161 are connected between the +300 volts and the plates of the output tubes, and the cathodes of the output tubes are connected to the attenuator. With the polarity switch in the negative position, the load (R158 through R161) is switched into the cathode circuit, and the plates of the output tubes are connected directly to the output attenuator. In either polarity position there is always a load in the plate circuit and a load in the cathode circuit. The only possible exception is when the attenuator switch S102 is in the X1 position, which is zero attenuation. There must be a load on the output connector under this condition, or the life of the output tubes can be affected.

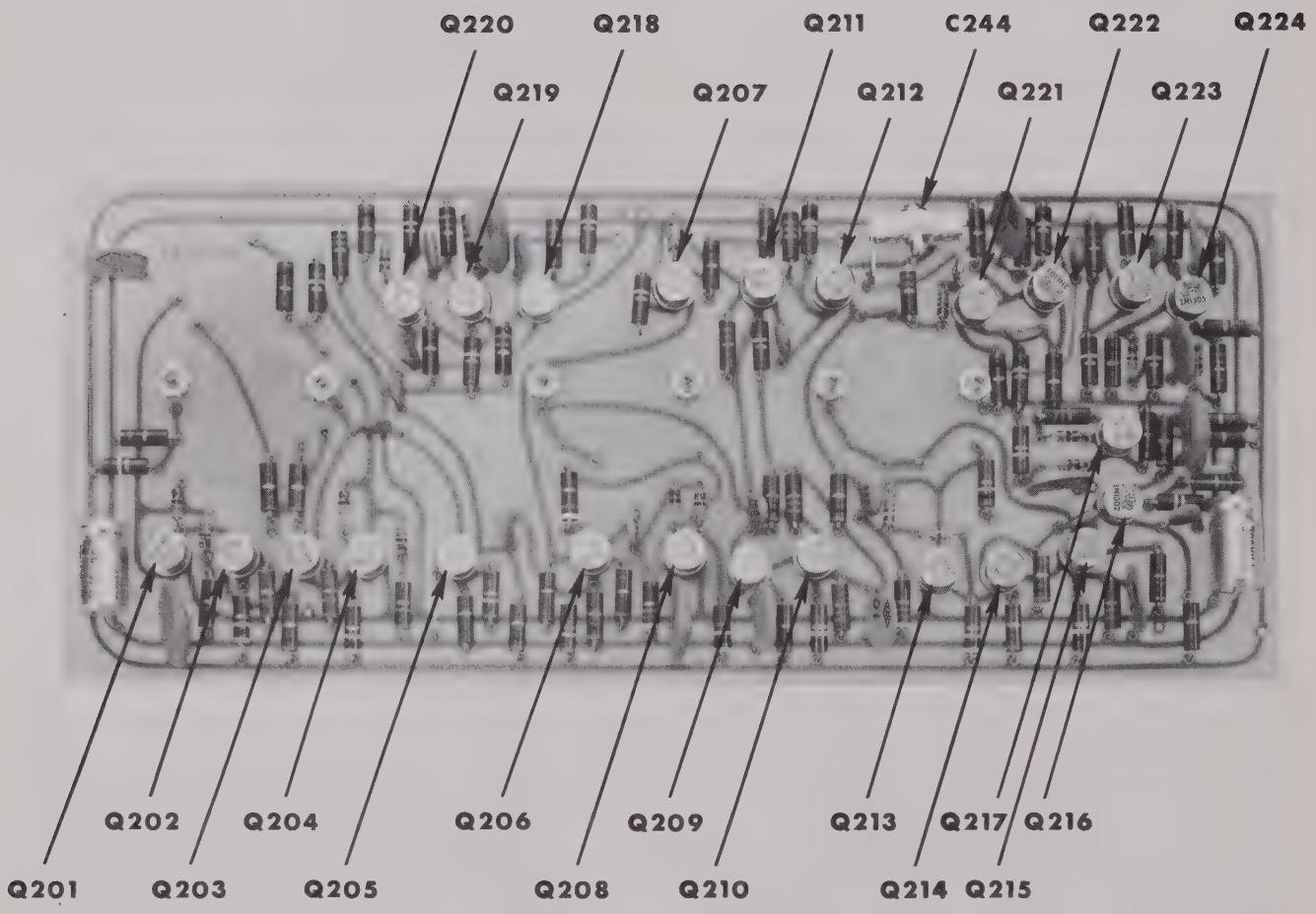
POWER SUPPLY

The supply consists of three high voltages for the tube circuitry and two low voltages for the transistor control circuitry. The high voltage supplies are floating so that either the V_O line can be grounded or the +300 volt line can be grounded. The -150 volt and the -300 volt supplies are determined by the VR tubes, V4 and V5. The +300 volt supply is referenced to the -150 volt VR tube, V4, through R12 with V1B as the feedback amplifier and V2 and V3 as the series regulators. The 6.3 volt AC winding of the transformer is tied to the +300 volt line and provides the filament current for the series regulators V2 and V3. The relay hold current is provided by rectifying this 6.3 volt supply by CR9, R22, and the capacitor C4. Another 6.3 volt filament winding provides filament power for V1 on the power supply and all the tubes on the output circuitry. The clamp voltage for the output circuitry is provided by the cathode follower V1B.

The +15 volts for the transistor circuitry is referenced to a 15 volt zener, CR14. Q1 is the series regulator, and Q2 is the feedback amplifier. The -15 volt supply is referenced to the +15 volt supply through R34 to the base of Q3. Transistor Q4 is the series regulator for the -15 volt bus.

OVERLOAD RELAY

The current from the +300 volt bus goes through the coil of the overload relay and through resistor R135. When the current through the relay coil resistor R135 causes a voltage drop across the relay coil of approximately 5 volts, the relay will operate, opening the normally closed contacts and closing the normally open contacts. The overload relay is held closed so that it will not chatter by the current from the power supply comprised of C4 and CR9. When the overload reset button is depressed, it shorts the relay and allows it to drop out.



CONTROL CIRCUITS

MAINTENANCE & CALIBRATION

COMPONENTS

Top quality components and precision manufacturing methods have been used in this instrument to insure a long life with a minimum of maintenance. Standard parts have been used whenever possible so that repairs, when necessary, can be performed with a minimum of down time.

The only selected components are diodes CR104, CR105, and CR116. CR105 and CR116 are Texas Instruments 1N914B's, selected for a minimum reverse voltage breakdown of 120 volts. In addition, CR104 and CR105 are selected so that the storage time of CR104 is less than that of CR105. This test is performed by placing the two diodes in the circuit and observing the output pulse at maximum amplitude. If the storage times of the two diodes are not correctly related, a notch in the pulse top will appear approximately 40 nanoseconds after the leading edge. This notch will completely disappear when the storage times of CR104 and CR105 are properly related. Selected diodes are available through your E-H representative.

FAN ASSEMBLY

The E-H Model 131 Pulse Generator is cooled by a fan that draws air into the instrument. The fan is life-time lubricated, and no preventive maintenance is necessary. However, if the instrument is mounted so that the air flow into it is restricted, it may overheat.

TEST EQUIPMENT

The following test equipment is recommended for calibration and servicing the pulse generator.

1. A Tektronix Type 540 with a Type L plug-in. This oscilloscope can be used for all measurements except rise time of the output pulse.

2. An oscilloscope having a very fast rise time, such as a Tektronix Type 580 or a sampling oscilloscope.

3. A DC voltmeter.

CALIBRATION

A. INSPECTION

Visually inspect the instrument to see that there are no leaky electrolytics, burnt resistors or wiring; that all the tubes are securely in place; and that the filaments light and the fan rotates freely when the AC switch is turned ON.

B. POWER SUPPLY

1. Set the POLARITY to +, terminate the output with 50 ohms, and check the power supply voltages of:

+300 volts
-300 volts
-150 volts
+ 15 volts
- 15 volts

They should be ±10 per cent. Adjust the +300 volt supply with variable resistor R6.

TROUBLE SHOOTING

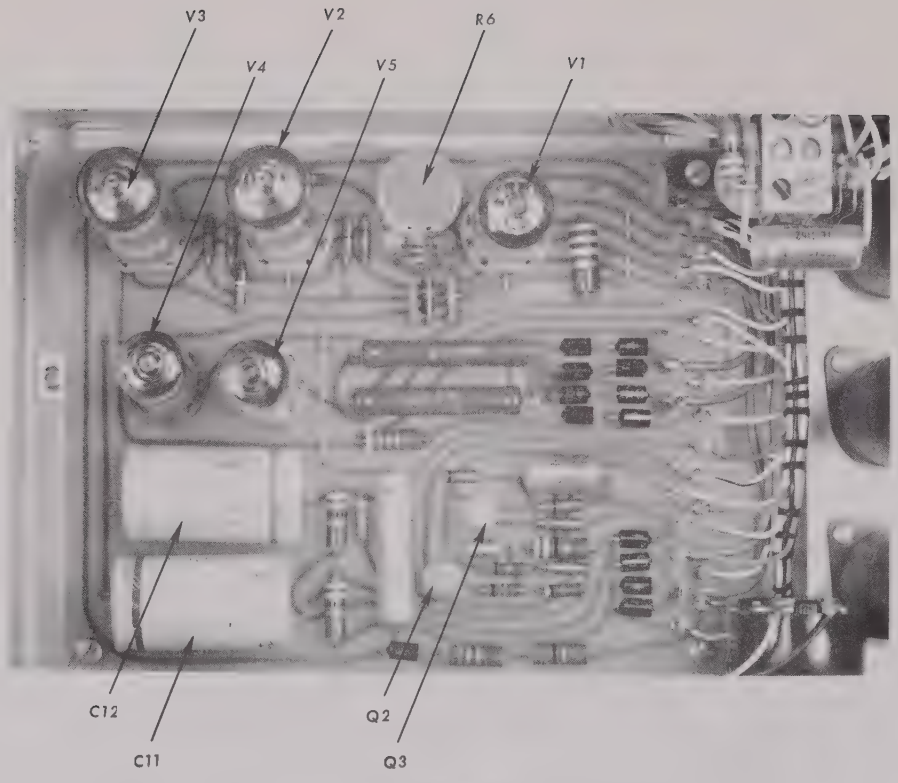
Power supply failures can usually be traced to a defective tube or diode, or a leaky electrolytic.

C. MULTIVIBRATOR

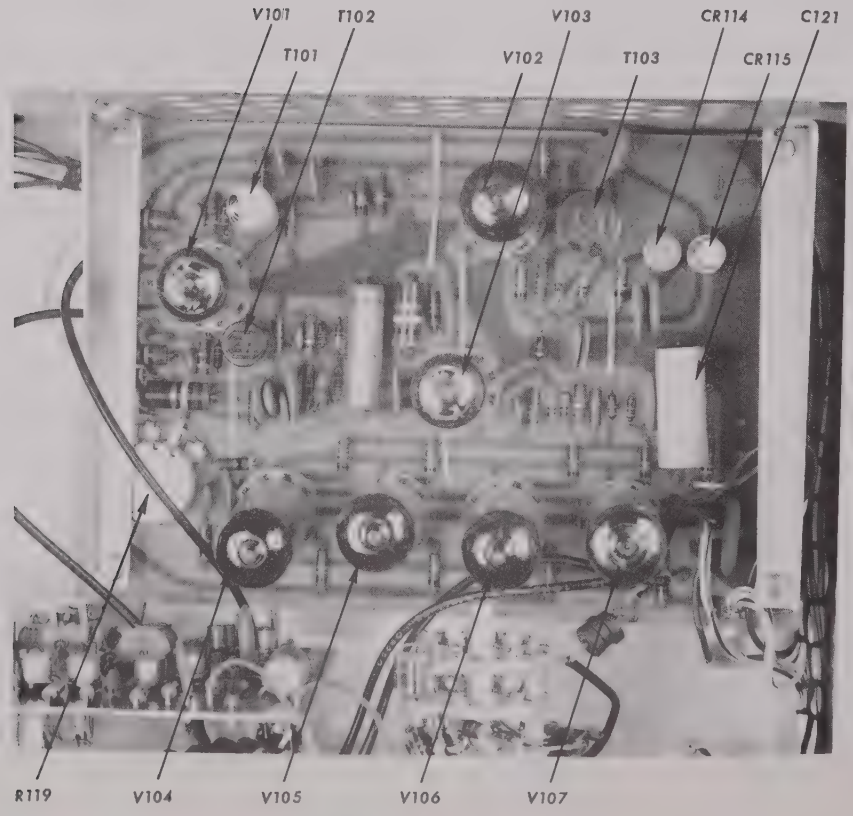
1. Set the FREQ. RANGE selector to 10-100 cps and the FINE control fully counterclockwise. Observe the output pulse chain, or if there is no output, observe the waveform on the collector of Q202. The frequency of the output pulses should be 10 cps or less. (The waveform on the collector of Q202 should have a period of 100 milliseconds or greater.)

2. Rotate the FINE frequency control fully clockwise and observe that the output frequency is 100 cps or greater. (Multivibrator period equals 10 milliseconds or less.)

3. Repeat steps 1 and 2 for each FREQ. RANGE position. There should be overlap from range to range, and the upper frequency limit should be



POWER SUPPLY



OUTPUT CIRCUITS

100 KC or greater. The components used to establish the frequency range are fixed values -- there are no variable capacitors or resistors with the exception of the FINE frequency potentiometer.

TROUBLE SHOOTING

1. Improper Multivibrator Output on All Ranges

a. Transistor placed in its socket incorrectly.

b. Possible defective transistor or diode, or dirty switch S201.

2. Incorrect Frequency Coverage or No Output on a Particular Range

a. Defective timing capacitor.

b. Dirty or defective switch contact.

D. TRIGGER OUTPUT

Observe the trigger output pulse on an oscilloscope. With no external load on the TRIGGER OUTPUT connector, the pulse is typically 15 volts in amplitude and 1.1 microseconds wide.

TROUBLE SHOOTING

No Trigger Output

First check whether the waveform on the collector of Q220 is present. If it is present, transistor Q218 or its biasing is most likely responsible for there not being a trigger output. No waveform or an improper waveform on the collector of Q220 indicates that the one-shot multivibrator (Q219 and Q220) is not operating properly or that it is not receiving the proper input signal. The input to the one-shot is best observed on the collector of Q205. This waveform should be a negative 15 volt pulse with a rise time of 0.2 microseconds or less. Pulses with rise times in excess of 0.3 microseconds when differentiated may not produce a strong enough signal on the base of Q220 to trigger the one-shot to its quasi-stable state.

E. DELAY ONE-SHOT

1. Set the oscilloscope to trigger externally on the trigger output of the Model 131.

2. Set the

DELAY selector - -1-10 us
FINE - fully ccw

WIDTH selector - 1-10 us
FINE - fully ccw

3. Observe the output pulse chain on the oscilloscope or, if there is no output, observe the waveform on the collector of Q209. Because the delay is set to -1 microsecond, the first pulse in the chain will occur before the oscilloscope is triggered. To determine how far the pulse output is advanced with respect to the trigger, slowly increase the pulse width until the trailing edge of the first pulse is just observable. Then adjust the delay controls so that the entire first pulse can be seen. The width of the pulse is equal to the maximum pulse output advance with respect to the trigger output. It should be 1 microsecond or greater.

4. Set the controls as in step 2 above, but turn the FINE delay fully clockwise. The output pulse should be 10 microseconds or more delayed with respect to the trigger output.

5. Check the coverage of the remaining delay ranges. There should be overlap between ranges, and the variable delay control should be smooth and continuous.

TROUBLE SHOOTING

1. Improper Delay One-Shot Output on All Ranges

a. Check the waveform on the collector of Q206 to be sure that the delay one-shot is receiving its proper input signal. If the waveform indicated on the schematic diagram is not present, check the condition of transistors Q205, Q206, Q207, and diode CR205.

b. Check the condition of the diodes and transistors in the delay one-shot.

2. Improper Delay Coverage on a Particular Range

a. Defective or off-value timing capacitor C215 through C217. Possible dirty or defective switch contact.

b. The -1 to 10 microsecond range can be adjusted by changing the value of R266 in the trigger output fixed delay multivibrator. Increasing the value of R266 will allow a greater amount of trigger delay with respect to the output pulse.

F. WIDTH

1. Set the WIDTH selector to the .1-1 microsecond range and rotate the FINE selector to minimum (fully counterclockwise).

2. On an oscilloscope observe the output pulse or, if there is no output pulse, observe the waveform on the collector of Q214. The pulse should be .1 microsecond or less in width. It can be adjusted by

variable capacitor C244. (The minimum period of the waveform on the collector of Q214 typically will be .6 microseconds. See the Time Relationship diagram.)

3. Rotate the FINE width control fully clockwise. The output pulse width should be 1 microsecond or greater.

4. Repeat steps 2 and 3 for each range of widths. There should be overlap between ranges and the variable width control should be smooth and continuous.

TROUBLE SHOOTING

1. Improper Width Waveform on All Ranges

a. Check the waveform on the collector of Q212 to be sure that the width one-shot is receiving its proper input signal. If the waveform indicated on the schematic diagram is not present, check the condition of transistors Q211 and Q212.

b. Transistors Q213, Q214, and Q215, as well as diodes CR208 and CR209, can cause malfunction of the width multivibrator.

2. Improper Width Coverage on a Particular Range

a. Defective or off-value timing capacitor C222 through C225; or possibly a dirty or defective switch contact.

b. If the minimum pulse width is not obtainable, check that Q221 and Q222 are providing the required delay.

G. OUTPUT PULSE

1. Latch

Check that the output pulse is present and that the latch operates properly (i.e., clean, well-defined pulse) at various conditions of amplitude, width, and duty cycle. If the latch is not operating properly, R119, the latch adjust, should be set to obtain a voltage drop of 0.95 volts across R118 with repetition rate set at 100 KC and width to 1 microsecond (10 per cent duty cycle).

TROUBLE SHOOTING

1. If no output pulse is present and if the waveforms observed in the previous paragraphs have all been satisfactory, check that the waveforms on the blocking oscillators are present as indicated. Try to localize the malfunction. If both blocking oscillators work satisfactorily, check the waveforms in the latch circuitry. (A discussion of the latch circuit operation is contained in the "Theory of Operation" section.) The various clamping diodes can be checked by observing the voltage levels in the latch section. Note that diodes CR104, CR105 and CR116 are selected. See the paragraph on "Components" for the details of selection.

2. A defective attenuator or polarity switch can also interrupt the pulse from reaching the output connector.

2. Amplitude and Attenuator

The pulse amplitude should be continuously and smoothly variable over a range of 2.5 to 1 or greater. Maximum amplitude should be 50 volts or greater, positive or negative polarity, into 50 ohms. The ATTENUATOR has a nominal 5 per cent accuracy.

TROUBLE SHOOTING

1. Inoperative Amplitude Control

Check the clamp voltage at the junction of CR105 and C121. The clamp voltage should vary with amplitude from typically -5 or 10 volts to 60 volts. If the clamp voltage does not vary, vacuum tube V1A, diode CR105, or capacitors C120 and C121 could be defective.

2. Less Than 50 Volts Maximum Amplitude

a. Make sure that the output is being loaded with 50 ohms, not less.

b. Check the clamp voltage as described above. If the maximum clamp voltage is low, check the condition of tube V1A, the +300 volt and -150 volt busses and the tolerance of resistors R18 and R20.

c. If the clamp voltage is proper, check the condition of the output tubes V104 through V107.

3. Duty Cycle

a. Set the front panel controls so that the

FREQUENCY	=	100 KC
DELAY	=	0
POLARITY	=	-
WIDTH	=	Minimum (.1 us)
AMPLITUDE	=	50 volts
ATTEN.	=	1

b. Observe the output pulse on an oscilloscope and increase the pulse width slowly until the overload relay disengages the output. The pulse width should be 1 microsecond or very slightly greater (10 per cent duty cycle at 100 KC) when the overload relay trips. If 10 per cent duty cycle is not obtainable at 50 volts output amplitude, resistor R135 (a 33 ohm, 1 watt resistor) should be padded. R135 is physically located on the overload relay. Do not pad R135 excessively to obtain a duty cycle much greater than 10 per cent. To do so will cause excessive drain on the power supply and also will exceed the dissipation ratings of the output tubes.

4. Rise and Fall Times

On an oscilloscope with a rise time of 5 nanoseconds or less, measure the rise and fall times of both the positive and negative output pulses at 50 volts amplitude. Typically, the negative pulse has a rise of 8 nanoseconds and a fall of 9 nanoseconds. The positive pulse has a rise of 10 nanoseconds and a fall of 11 nanoseconds.

NOTE

When measuring rise and fall times, it is important to take into consideration the rise time of the oscilloscope. The rise time observed on an oscilloscope with a gaussian rise is, to a first approximation, equal to the square root of the sum of the squares of the oscilloscope rise time and the pulse rise time.

For example:

Observed rise time = 11 nanoseconds

Scope rise time = 4.5 nanoseconds

Pulse rise time $= \sqrt{(11)^2 - (4.5)^2}$

$= \sqrt{121 - 20}$

$= \sqrt{101}$

= 10 nanoseconds

TROUBLE SHOOTING

1. Observed rise and fall times that are appreciably slower than typical are often the result of using an oscilloscope, such as a Tektronix 540, which does not have a sufficiently fast rise time. Oscilloscope sweep speeds which may be out of calibration can cause an apparent slow rise or fall time. Termination of the Model 131 in other than 50 ohms will also affect rise time.

2. Rise and fall times that are actually an appreciable amount slower than typical can be improved by replacing amplifier tube V102 (only Amperex tubes are recommended), one or all of the output tubes V104 through V107, or latch tube V103. Dirty or defective polarity and impedance switches can also affect rise and fall times.

5. Jitter

a. Jitter in the Model 131 is of two types. One type is trigger jitter -- variation of the pulse output with respect to the trigger output. This jitter is of a fixed amount, independent of repetition rates, widths, etc., and is less than 4 nanoseconds, short-term peak-to-peak. Trigger jitter can be measured on an oscilloscope by externally triggering the oscilloscope and observing the output pulse of the Model 131 on a very fast sweep, 20 nanoseconds per centimeter or faster.

b. The second type of jitter in the Model 131 is a combination of repetition rate, width, and delay jitter. By utilizing the sweep magnification feature of the oscilloscope this jitter can be measured to be less than 0.2 per cent.

TROUBLE SHOOTING

1. Excessive Trigger Jitter

a. Trigger jitter is proportional to ripple on the +15 volt and -15 volt supplies. Ripple in excess of 10 millivolts on either supply can cause jitter in excess of 4 nanoseconds. A weak zener diode CR14, a leaky electrolytic capacitor, or a poor ground connection on these capacitors can cause excessive ripple.

b. Excessive trigger jitter will also result if the fixed multivibrator composed of Q219 and Q220 jitters.

2. Excessive Repetition Rate, Width or Delay Jitter

First determine whether the jitter is a function of the repetition rate, width or delay controls. Then inspect the appropriate section of the control circuitry to determine the defective component.

6. Waveform

a. Overshoot on either positive or negative pulses is typically less than 5 per cent under any conditions of amplitude and duty cycle. There are no significant notches or bumps on the pulse or on the base line following the pulse, excepting approximately 10 per cent overshoot on the trailing edge of the negative pulse.

b. There is a small amount of distortion of the pulse top that can best be measured by setting the controls as follows:

REP. RATE	=	100 KC
WIDTH	=	2 microseconds
AMPLITUDE	=	Minimum
ATTEN.	=	1

The amount of this distortion is less than 1 volt peak-to-peak and is virtually independent of amplitude.

TROUBLE SHOOTING

1. Excessive Overshoot

The design of the Model 131 is such that excessive overshoot is not likely to occur. Therefore, it is usually wisest to inspect the oscilloscope when overshoot is observed. Make sure that the oscilloscope probe is properly compensated and, if possible, check the performance of the Model 131 on a second oscilloscope. It is almost a sure sign that the oscilloscope is contributing overshoot if the overshoot appears the same on both the leading and the falling edges of the pulse.

If it is determined that the pulse does have overshoot, it is probably contributed by a weak output tube or by dirty or worn switch contacts.

2. Notch in the Pulse at 50 Volt Amplitude

This notch is due to the comparative storage times of CR104 and CR105. These diodes are selected and the details of their selection are contained in the paragraph on "Components."

H. FUNCTIONS

1. External Drive

The instrument can be externally driven from a 2 volt positive pulse. Failure to drive externally is probably due to a defective switch if the frequency multivibrator free-runs properly.

2. Gate

The gate action can be observed on the output pulse train when a positive 2 volt signal is applied to the GATE INPUT. The gating action should be clean and undistorted.

TROUBLE SHOOTING

1. Improper gating can be caused by incorrect latch adjust. See paragraph G-1 for proper adjustment.

2. Defective transistor Q207 or diode CR205 also can cause malfunction of the gate.

PARTS LIST

IMPORTANT

ORDERING INFORMATION

Please include the following information when ordering a replacement part.

1. Model and serial number of the instrument for which the replacement part is intended.

2. Circuit reference of the replacement part.

3. E-H stock number.

Replacement parts may be ordered through your E-H representative or from the factory.

CUSTOMER SERVICE DEPARTMENT
E-H RESEARCH LABORATORIES, INC.
1 6 3 ADELINE STREET,
OAKLAND 20, CALIFORNIA.
Phone: TE 4-3030
Area Code 415

PLEASE NOTE!

CAPACITORS

Circuit Reference	Description	E-H Part No.
C1	60 uf, 350 wvdc fixed, electrolytic	316 034
C2	Same as C1.	
C3	.01 uf, ±20%, 600v fixed, ceramic	311 012
C4	250 uf, 15 wvdc fixed, electrolytic	316 020
C5	250 uf, 50 wvdc fixed, electrolytic	316 025
C6	Same as C5.	
C7	Same as C3.	
C8	25 uf, 25 wvdc fixed, electrolytic	316 028
C9-C10	Same as C1.	
C11-C12	Same as C5.	
C101	100 pf, ±10%, 1 KV fixed, ceramic	311 007
C102	Not used.	
C103	Same as C101.	
C104	Not used.	
C105	.001 uf, ±10%, 1 KV fixed, ceramic	311 010
C106	Same as C3.	
C107	.002 uf, ±10%, 1 KV fixed, ceramic	311 017
C108	.1 uf, 500 v fixed, ceramic	311 023
C109	Same as C101.	
C110	Same as C3.	
C111	.1 uf, ±20%, 75 v fixed, ceramic	311 014
C112	Same as C3.	
C113	Same as C101.	
C114	Same as C105.	
C115	Same as C3.	
C116	Same as C108.	
C117	Same as C3.	
C118	Same as C101.	
C119	Same as C3.	
C120	Not used.	
C121	2.5 uf, ±5%, 200 wvdc fixed, mylar	320 018
C122	Same as C3.	
C123	Same as C111.	
C124	Same as C101.	
C125	Same as C111.	
C126	Same as C4.	
C127	10 uf, 15 wvdc fixed, electrolytic	316 033
C128	20 pf, ±10%, 1 KV fixed, ceramic	311 002
C129	Same as C128.	
C130	Not used.	
C131	Same as C108.	
C132	30 pf, ±20%, 500 KV fixed, ceramic	311 005
C133	3.3 pf, ±5%, 1 KV fixed, ceramic	311 022
C134	Not used.	
C201-C202	Same as C8.	
C203	.001 uf, ±5%, 500v fixed, polystyrene	326 005
C204	.01 uf, ±5%, 500v fixed, polystyrene	326 006
C205	.1 uf, ±5%, 200v fixed, mylar	320 007
C206	1.0 uf, ±5%, 200v fixed, mylar	320 011
C207	Same as C203.	
C208	Same as C204.	
C209	Same as C205.	
C210	Same as C206.	

Circuit Reference	Description	E-H Part No.
C211	500 pf, ±10%, 1 KV fixed, ceramic	311 009
C212-C213	Same as C211.	
C214	150 pf, ±10%, 1 KV fixed, ceramic	311 008
C215	.05 uf, ±5%, 200 wvdc fixed, mylar	320 005
C216	.005 uf, ±5%, 500 wvdc fixed, polystyrene	326 004
C217	500 pf, ±5%, 500 wvdc fixed, polystyrene	326 003
C218	Same as C101.	
C219	Same as C3.	
C220	250 pf, ±10%, 1 KV fixed, ceramic	311 004
C221	Same as C220.	
C222	250 pf, ±5%, 500 wvdc fixed, polystyrene	325 011
C223	Same as C217.	
C224	Same as C216.	
C225	.02 uf, ±20%, 1 KV fixed, ceramic	311 013
C226	Same as C220.	
C227	Same as C3.	
C228	Same as C220.	
C229	Same as C3.	
C230	Same as C111.	
C231	Same as C105.	
C232	Same as C111.	
C233	Same as C220.	
C234	Same as C105.	
C235	Same as C101.	
C236	Not used.	
C237-C238	Same as C101.	
C239	Same as C211.	
C240	Same as C3.	
C241	Same as C214.	
C242-C243	Same as C3.	
C244	7-100 pf, 400 v variable, ceramic	332 003
C245	Same as C111.	
C246	Same as C3.	
C247	Same as C111.	
C248	Same as C3.	

DIODES

CR1-CR13	Type 1N2071, Texas Instruments	376 034
CR14	Type 3/4M15Z10, zener Motorola	374 034
CR101	Type 1N914B, Texas Instruments	376 022
CR102	Same as CR101.	
CR103	Type 1N270, Sylvania	376 031
CR104	Type 1N914B, selected, Texas Instruments	376 022-A
CR105	Type 1N914B, selected, Texas Instruments	376 022-B
CR106	Same as CR105.	
CR107	Not used.	
CR108-111	Same as CR103.	
CR112	Not used.	
CR113	Same as CR103.	
CR114	Type 1.5M20Z10, zener, Motorola	374 030
CR115	Type 1.5M25Z10, zener, Motorola	374 031
CR116	Type 1N914B, selected Texas Instruments	376 022-C
CR117	Same as CR116.	
CR118	Not used.	
CR201-215	Same as CR103.	

NOTE: Replacement tubes, transistors and diodes must be from manufacturer indicated to insure proper operation.

Circuit Reference	Description	E-H Part No.
RESISTORS		
R1	4.7 ohms, ±5%, 1 w, fixed, composition	597 047
R2	220 K, ±5%, 1/2 w, fixed, composition	596 224
R3-R5	Same as R2.	
R6	100 K, 2 w, variable, wirewound	550 026
R7	6 K, ±5%, 10 w, fixed, wirewound	610 043
R8	20 K, ±5%, 10 w, fixed, wirewound	610 041
R9	Same as R2.	
R10	150 K, ±5%, 1/2 w, fixed, composition	596 154
R11	300 K, ±5%, 1/2 w, fixed, composition	596 304
R12	120 K, ±5%, 1/2 w, fixed, composition	596 124
R13	1 K, ±5%, 1/2 w, fixed, composition	596 102
R R14	22 ohms, ±5%, 1/2 w, fixed, composition	596 220
R15	22 ohms, ±5%, 1 w, fixed, composition	597 220
R16	Same as R13.	
R17	Same as R14.	
R18	330 K, ±5%, 1/2 w, fixed, composition	596 334
R19	100 K, 2 w, variable, composition	550 006
R20	160 K, ±5%, 1/2 w, fixed, composition	596 164
R21	33 K, ±5%, 2 w, fixed, composition	598 333
R22	2.7 ohms, ±5%, 1 w, fixed, composition	597 027
R23	33 ohms, ±5%, 1 w, fixed, composition	597 330
R24	Same as R23.	
R25	27 K, ±5%, 1/2 w, fixed, composition	596 273
R26	Not used.	
R27	39 ohms, ±5%, 1 w, fixed, composition	597 390
R28	1.2 K, ±5%, 1/2 w, fixed, composition	596 122
R29	3 K, ±5%, 1/2 w, fixed, composition	596 302
R30	Same as R13.	
R31	100 ohms, ±5%, 1/2 w, fixed, composition	596 101
R32	4.7 K, ±5%, 1/2 w, fixed, composition	596 472
R33	Same as R28.	
R34-R35	Same as R13.	
R101	220 ohms, ±5%, 1/2 w, fixed, composition	596 221
R102	27 K, ±5%, 1 w, fixed, composition	597 273
R103	2.2 K, ±5%, 1/2 w, fixed, composition	596 222
R104	2.4 K, ±5%, 1/2 w, fixed, composition	596 242
R105	Same as R104.	
R106	Same as R103.	
R107	Same as R102.	
R108	47 ohms, ±5%, 1/2 w, fixed, composition	596 470
R109	Same as R101.	
R110	Same as R10.	
R111	20 K, ±5%, 1/2 w, fixed, composition	596 203
R112-R113	Same as R31.	
R114	100 K, ±5%, 1/2 w, fixed, composition	596 104
R115	620 ohms, ±5%, 1/2 w, fixed, composition	596 621

Circuit Reference	Description	E-H Part No.
R116	Same as R31.	
R117	Same as R103.	
R118	Same as R108.	
R119	500 ohms, 2 w, variable, composition	550 015
R120	330 ohms, ±5%, 1/2 w, fixed, composition	596 331
R121	100 K, ±5%, 2 w, fixed, composition	598 104
R122	Same as R25.	
R123	Same as R28.	
R124	180 K, ±5%, 1/2 w, fixed, composition	596 184
R125	62 K, ±5%, 1/2 w, fixed, composition	596 623
R126	5.1 K, ±5%, 1/2 w, fixed, composition	596 512
R127-R134	Same as R31.	
R135	Same as R23.	
R135A	Optimum value selected at factory, fixed, composition	
R136	Same as R10.	
R137	Same as R13.	
R138	200 ohms, ±5%, 2 w, fixed, composition	598 201
R139	150 ohms, ±5%, 2 w, fixed, composition	598 151
R140	Same as R139.	
R141	130 ohms, ±5%, 2 w, fixed, composition	598 131
R142	120 ohms, ±5%, 2 w, fixed, composition	598 121
R143-R144	Same as R138.	
R145	100 ohms, ±5%, 1 w, fixed, composition	597 101
R146	Same as R145.	
R147	Same as R138.	
R148	430 ohms, ±5%, 1 w, fixed, composition	597 431
R149	150 ohms, ±5%, 1/2 w, fixed, composition	596 151
R150	Same as R149.	
R151	Same as R138.	
R152	51 ohms, ±5%, 1 w, fixed, composition	597 501
R153	910 ohms, ±5%, 1/2 w, fixed, composition	596 911
R154	Same as R148.	
R155	1.6 K, ±5%, 1/2 w, fixed, composition	596 162
R156	12 K, ±5%, 2 w, fixed, composition	598 123
R157	10 K, ±5%, 1/2 w, fixed, composition	596 103
R158-R163	Same as R139.	
R201	51 K, ±5%, 1/2 w, fixed, composition	596 513
R202	Same as R13.	
R203	8.2 K, ±5%, 1/2 w, fixed, composition	596 823
R204	Same as R19.	
R205	120 ohms, ±5%, 1/2 w, fixed, composition	596 121
R206	30 K, ±5%, 1/2 w, fixed, compostion	596 303
R207	750 ohms, ±5%, 1/2 w, fixed, composition	596 751
R208	Not used.	
R209	Same as R13.	
R210	Same as R207.	
R211	Same as R206.	
R212	Same as R203.	
R213	Same as R19.	
R214	Same as R205.	

Circuit Reference	Description	E-H Part No.
R215	Same as R114.	
R216	Same as R126.	
R217	15 K, ±5%, 1/2 w, fixed, composition	596 153
R218	Same as R103.	
R219	Same as R13.	
R220-R221	Same as R217.	
R222	Same as R13.	
R223	1.5 K, ±5%, 1/2 w, fixed, composition	596 152
R224	Same as R103.	
R225	470 ohms, ±5%, 1/2 w, fixed, composition	596 471
R226	9.1 K, ±5%, 1/2 w, fixed, composition	596 912
R277	Same as R19.	
R228	Same as R206.	
R229	Same as R13.	
R230	Same as R223.	
R231	510 ohms, ±5%, 1/2 w, fixed, composition	596 511
R232	Same as R111.	
R233	Same as R231.	
R234	22 K, ±5%, 1/2 w, fixed, composition	596 223
R235	Same as R231.	
R236	Same as R103.	
R237	Same as R111.	
R238	Same as R231.	
R239	Same as R13.	
R240	Same as R225.	
R241	Same as R157.	
R242	Same as R19.	
R243	Same as R206.	
R244	33 K, ±5%, 1/2 w, fixed, composition	596 333
R245	Same as R13.	
R246	Same as R223.	
R247	Same as R115.	
R248	Same as R111.	
R249	Same as R231.	
R250	Same as R234.	
R251	Same as R231.	
R252	Same as R103.	
R253	7.5 K, ±5%, 1/2 w, fixed, composition	596 752
R254	Same as R231.	
R255	2 K, ±5%, 1/2 w, fixed, composition	596 202
R256	Same as R149.	
R257	Same as R13.	
R258	560 ohms, ±5%, 1/2 w, fixed, composition	596 561
R259	Same as R231.	
R260	Same as R234.	
R261	Same as R258.	
R262	Same as R234.	
R263	Same as R258.	
R264	Same as R223.	
R265	Same as R13.	
R266	12 K, ±5%, 1/2 w, fixed, composition	596 123
R267	Same as R225.	
R268	Same as R13.	
R269	Same as R225.	
R270	Same as R157.	
R271	Same as R13.	

Circuit Reference	Description	E-H Part No.
R272	Same as R223.	
R273	Same as R207.	
R274	Same as R111.	
R275	Same as R231.	
R276	Same as R234.	
R277	Same as R231.	
R278	Same as R103.	
R279	Same as R253.	
R280	Same as R231.	
R281	Same as R149.	
R282	Same as R13.	
R283	Same as R255.	
R284-R285	Same as R234.	
INDUCTORS		
L101	.33 uh, ±20%, 1/3 w, fixed, phenolic	335 010
L102	1.5 uh, ±10%, 1/3 w, fixed, phenolic	335 015
L103	.68 uh, ±20%, 1/3 w, fixed, phenolic	335 013
TRANSFORMERS		
T1	power transformer	653 001
T101	pulse transformer, non-inverting	A-10284-01
T102	Same as T101.	
T103	pulse transformer, inverting	A10285-01
VACUUM TUBES		
V1	Type 7119, Amperex	670 021
V2	Type EL84/6BQ5, Amperex	670 001
V3	Same as V2.	
V4	Type OA2	670 007
V5	Same as V4.	
V101	Same as V1.	
V102	Same as V2.	
V103	Same as V1.	
V104-V107	Same as V2.	
TRANSISTORS		
Q1	Type 2N250, Texas Instruments	663 026
Q2	Type 2N1304, Texas Instruments	663 013
Q3	Type 2N1305, Texas Instruments	663 017
Q4	Same as Q1.	
Q201	Type 2N1303, Texas Instruments	663 011
Q202-Q204	Same as Q201.	
Q205	Type 2N1302, Texas Instruments	663 016
Q206-Q210	Same as Q201.	
Q211	Same as Q205.	
Q212-Q215	Same as Q201.	
Q216	Same as Q205.	
Q217	Same as Q3.	
Q218	Same as Q201.	
Q219-Q220	Same as Q205.	
Q221-Q222	Same as Q201.	
Q223	Same as Q2.	
Q224	Same as Q3.	

NOTE: Replacement tubes, transistors and diodes must be from manufacturer indicated to insure proper operation.

Description	E-H Part No.
MISCELLANEOUS	
Pilot Light Assembly	510 004
AC Switch, Smith 512	630 002
Fuse Holder	396 001
Reset Switch, Grayhill 40-1 Clear	510 009
Polarity Switch, CRL 024-4037, 6 pole, 2 position, shorting	624 023
Attenuator, CRL 024-4300, 4 deck, 12 position	624 028
Freq. Switch, CRL PS-028160 (Index) CRL PA-2 (2) (Deck)	624 011 624 034
Width Switch, CRL PS-028160 (Index) CRL PA-2 (Deck)	624 011 624 034
Delay Switch, CRL PS-028160 (Index) CRL PA-2 (Deck)	624 011 624 034
Power Cord, Belden 17460-S	786 001
Fan Motor, Barber Colman DYAB 569	543 001
Fan Blade, 4" ccw, Torrington 0429-4	388 005
Relay, Automatic Electric, 150 ohms, PP-70060-15A	584 002

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APP'V'D	E. O.
A		6/22/64	G.B.	J.G.	J.G.	

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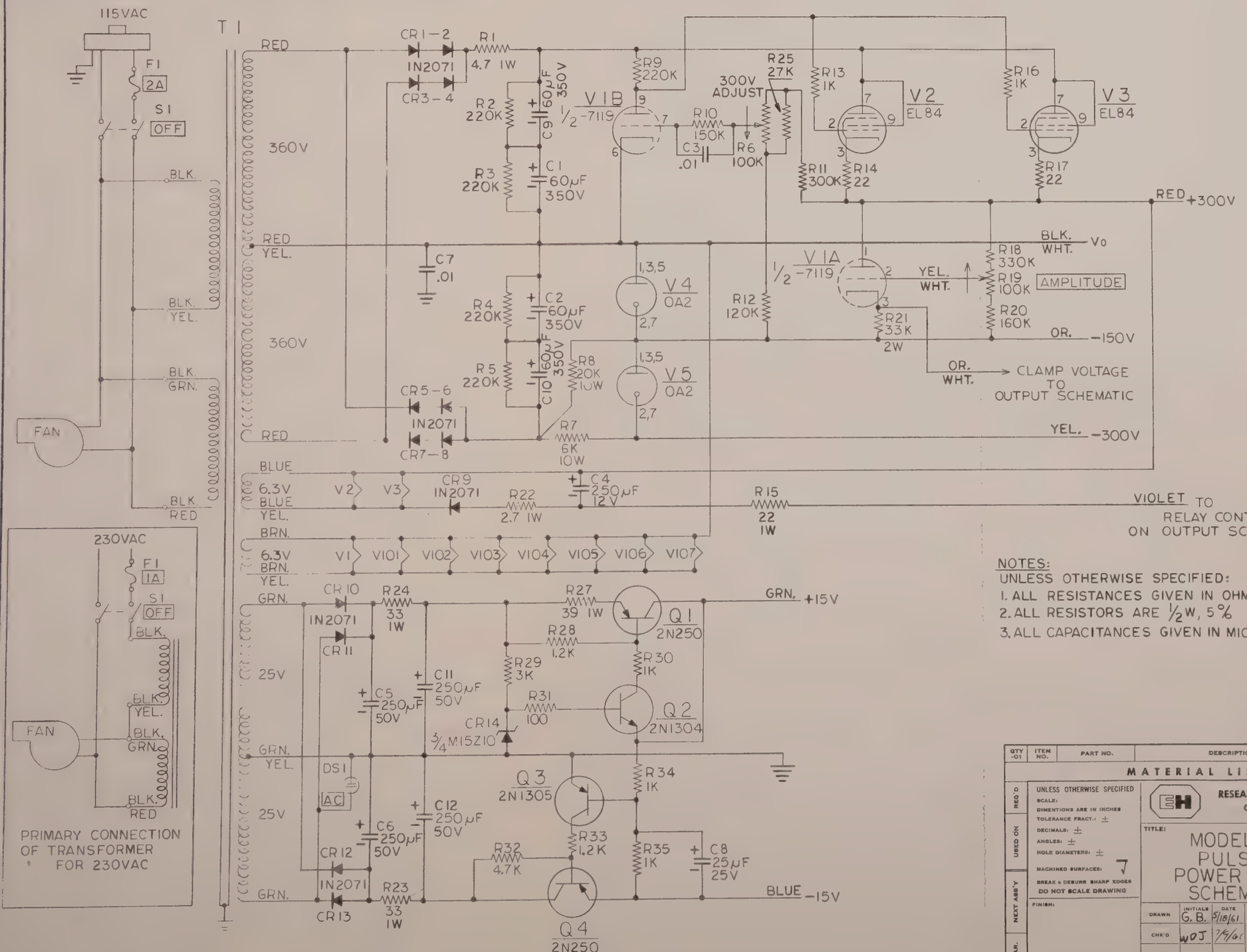

C-

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE ½W, 5%
3. ALL CAPACITANCES GIVEN IN MICRO-FARAD

QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF.

MATERIAL LIST

REQ'D | USED ON | NEXT ASS'Y | VAR.

UNLESS OTHERWISE SPECIFIED
SCALE:
DIMENTIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: 7
BREAK & DEBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE:
MODEL 131
PULSER
POWER SUPPLY
SCHEMATIC

	INITIALS	DATE	I.D. NO	DWG. NO.	ISSUE
DRAWN	G. B.	5/18/61		C-	
CHK'D	WOJ	7/5/61			
APP'D					

SHEET NO. ____ OF ____ SHEETS

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E. O.
A		6/22/62	G.B.	J.G.	J.G.	

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TITLE: D-

SHEET NO. ___ OF ___

FREQ. RANGE

DELAY S202

WIDTH S203

D-

EXT. DRIVE INPUT

R201 51K

R202 1K

S201 500pF

EXT. 10-100

CPS 100-1000

KC 1-10

10-100

R203 8.2K

C203-6

C207-11

R212 8.2K

R213 100K

FINE

R204 100K

R215 100K

+15V

R216 5.1K

2 μs

1.6 μs

0V

-15V

C247 .1

C248 .01

R223 1.5K

R226 9.1K

R227 100K

C217 — 500pF

C216 — .005

C215 — .05

.7 μs

-5V

C225 — .02

C224 — .005

C223 — 500pF

C222 — 250pF

R241 10K

R242 100K

R244 33K

BLUE

C201 25μF 25V

CR201 IN270

R205 120

Q201 2N1303

Q202-3 2N1303

R207 750

R210 750

Q204 2N1303

CR202 IN270

CR203 IN270

CR204 IN270

R214 120

C212 500pF

R217 15K

Q205 2N1302

R218 2.2K

R219 1K

C202 25μF 25V

C245 .1

C246 .01

R206 30K

R209 1K

R211 30K

C213 500 pF

R222 15K

Q206 2N1303

R222 1K

C214 150pF

R224 2.2K

CR206 IN270

Q207 2N1303

CR205 IN270

R225 470

R220 15K

Q208 2N1303

R229 1K

R231 510

Q209 2N1303

Q210 2N1303

R228 30K

R230 1.5K

R234 22K

C218 100pF

R235 510

Q211 2N1302

C219 .01

R233 510

R232 20K

R236 2.2K

Q212 2N1303

C220 250pF

R238 510

R237 20K

R239 1K

C221 250pF

CR208 IN270

CR209 IN270

R240 470

Q213 2N1303

R245 1K

R247 620

R250 22K

C226 250pF

R251 510

Q214 2N1303

Q215 2N1303

Q216 2N1302

C227 .01

R249 510

R248 20K

R252 2.2K

C228 250pF

CR210 IN270

R254 510

R255 2K

R285 22K

CR215 IN270

C229 .01

STOP PULSE TO C103 OUTPUT SCHEMATIC

Q217 2N1305

C230 .1

R257 1K

R253 7.5K

R250 150

55V

41μs

0V

+15V

GREEN

Q218 2N1303

1.2μs

R260 22K

R263 560

R265 1K

R266 12K

C233 250pF

C234 .001

R259 510

Q219 2N3C2

CR211 IN34

C235 100pF

R267 470

Q220 2N1302

C232 .1

R261 560

R262 22K

R264 1.5K

R268 1K

GATE INPUT

TRIGGER OUTPUT

C231 .001

R258 560

Q221 2N1303

R272 1.5K

R274 20K

Q222 2N1303

R278 2.2K

R279 7.5K

R281 150

R282 1K

C242 .01

R280 510

C237 100pF

CR212 IN270

R269 470

C238 100pF

C244 7-100pF

R275 510

C240 .01

C239 500pF

R276 22K

R277 510

Q223 2N1304

C241 150pF

CR213 IN270

Q224 2N1305

CR214 IN270

C243 .01

START PULSE TO C101 OUTPUT SCHEMATIC

R270 10K

R271 1K

R273 750

R283 2K

R284 22K

0V

-15V

0.8 μs

-5V

-12V

0.5 μs

+15V

+4V

4 μs

1.2 millisec.

WAVEFORMS OBSERVED ON TEKTRONIX TYPE 540 OSCILLOSCOPE WITH MODEL 131 CONTROLS AS FOLLOWS:

1. FREQUENCY RANGE = 1-10KC
   FINE FULL CCW
2. DELAY - 1-10μsec.
   FINE FULL CCW
3. WIDTH 0.1-1μsec.
   FINE FULL CCW
4. POLARITY +
5. AMPLITUDE MAXIMUM

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE ½W, 5%
3. ALL CAPACITANCES GIVEN IN MICRO-FARAD

QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
SCALE:
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK + DEBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

REQ'D | USED ON | NEXT ASS'Y | VAR.

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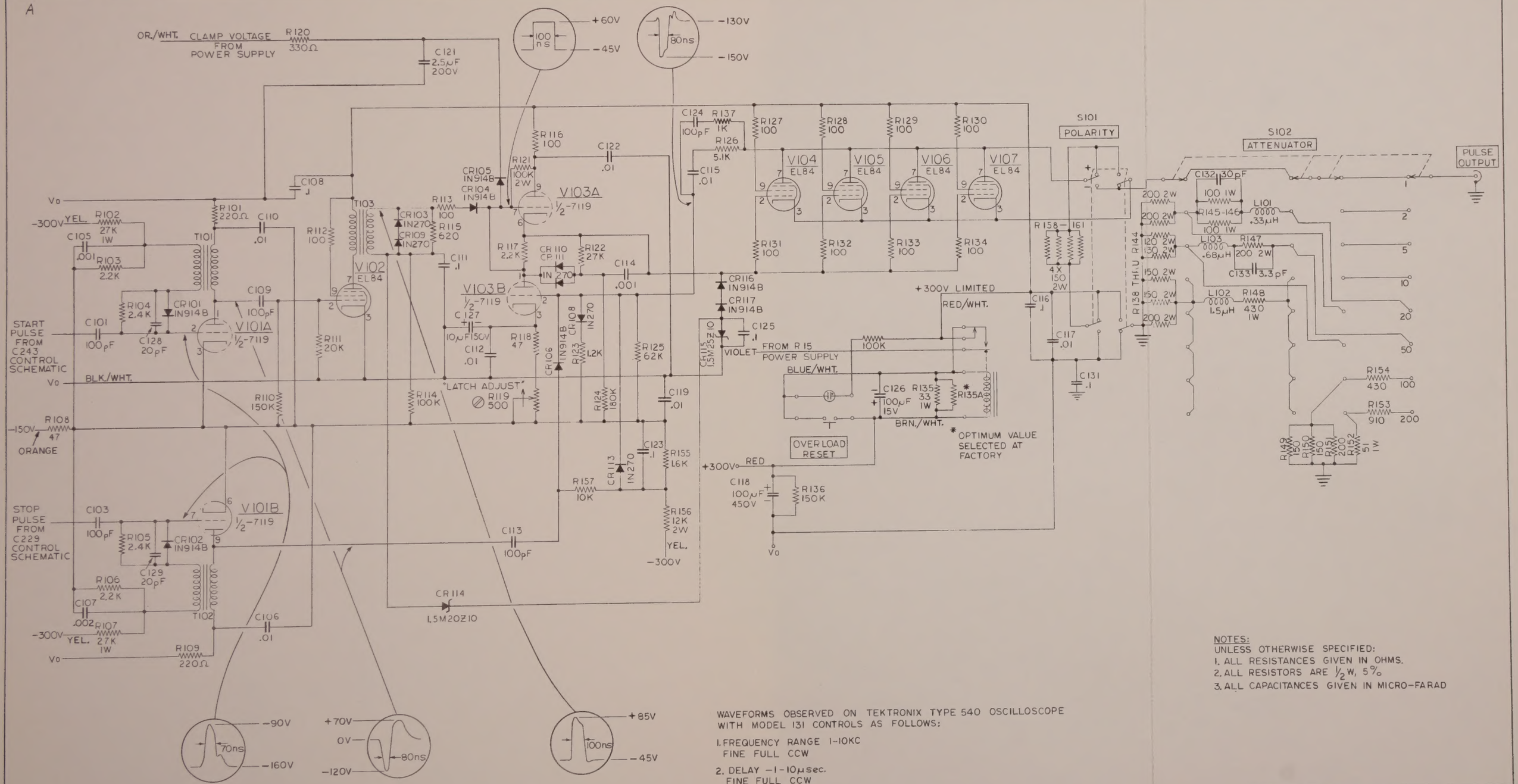
TITLE:
MODEL 131
PULSER
CONTROL SCHEMATIC

	INITIALS	DATE	I.O. NO	DWG NO	ISSUE
DRAWN	G. B.	7/20/61		D-	
CHK'D	WDT	7/9/62			
APP'D					

SHEET NO. ___ OF ___ SHEETS

A



WAVEFORMS OBSERVED ON TEKTRONIX TYPE 540 OSCILLOSCOPE WITH MODEL 131 CONTROLS AS FOLLOWS:

1. FREQUENCY RANGE 1-10KC
   FINE FULL CCW
2. DELAY -1-10μsec.
   FINE FULL CCW
3. WIDTH .1-1μsec.
   FINE FULL CCW
4. POLARITY +
5. AMPLITUDE MAXIMUM

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTANCES GIVEN IN OHMS.
2. ALL RESISTORS ARE 1/2 W, 5%
3. ALL CAPACITANCES GIVEN IN MICRO-FARAD

QTY -01	ITEM NO.	PART NO.	DESCRIPTION	SCHEMATIC OR SPEC. REF

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
SCALE:
DIMENSIONS ARE IN INCHES
TOLERANCE FRACT.: ±
DECIMALS: ±
ANGLES: ±
HOLE DIAMETERS: ±
MACHINED SURFACES: √
BREAK & DEBURR SHARP EDGES
DO NOT SCALE DRAWING
FINISH:

REQ'D | USED ON | NEXT ASS'Y | VAR.

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE:
MODEL 131
PULSER
OUTPUT SCHEMATIC

	INITIALS	DATE	I.D. No.	DWG. NO.	ISSUE
DRAWN	G. B.	12/23/61		D-	
CHK'D	WDJ	1/9/62			
APP'D				SHEET NO. ___ OF ___ SHEETS	

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